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STUDIES ON LYMPHATIC FILARIASIS

AT

VECTOR CONTROL RESEARCH CENTRE
PONDICHERRY

ABSTRACTS OF PAPERS PUBLISHED (1975-1990)

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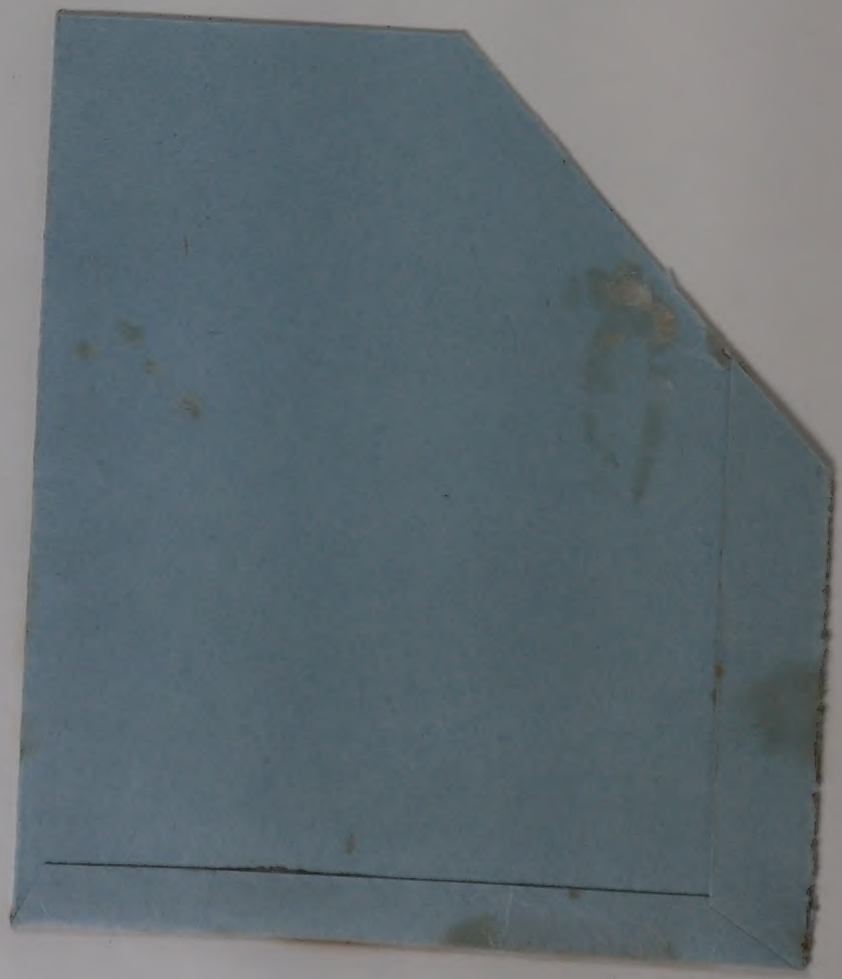

CONTENTS

Page..No.

1. INTRODUCTION..... 01
2. FILARIASIS IN INDIA..... 02
3. ABSTRACTS
    - A. CONTROL..... 07
    - B. VECTOR BIOLOGY AND ECOLOGY..... 14
    - C. PARASITE EPIDEMIOLOGY..... 16
    - D. CLINICAL EPIDEMIOLOGY..... 23
    - E. SOCIO-ECONOMIC RESEARCH..... 25
    - F. MISCELLANEOUS..... 26

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INTRODUCTION

The Vector Control Research Centre (VCRC) has identified lymphatic filariasis as a thrust area for research since its very inception in 1975. Without adequate staff and facilities which are constraints associated with any newly started institution, some pioneering basic studies were made by the VCRC in Pondicherry (1975-80) and which was followed by a five year Filariasis Control Demonstration Project through integrated vector management (1981-85) for the control of bancroftian filariasis vector. The 'Pondicherry Project', as it is known now, was the first of its kind anywhere in the world, and has been highly commended by the World Health Organization (Tech.Rep.Series,688,1983) and several other international bodies. With the rich experience gained from this project, the VCRC in 1986 started another project in Shertallai, Kerala, for controlling malayan filariasis with integrated disease vector management strategy. For the liquidation of the focus of transmission, apart from environmental and biological control of vectors, emphasis is also given on chemotherapy and massive community participation. Again for the first time, an unique people's movement has been created for disease control and which is financially supported by banks and other organizations.

Presently the VCRC is engaged in detailed analysis of the large data bases created from the above projects. The studies now being carried out on 'Parasite Epidemiology' have the ultimate objective of providing a comprehensive understanding of the natural history, transmission dynamics of the disease and developing mathematical models for predicting the outcome of intervention measures in different situations.

This publication is brought out to highlight the studies carried out since 1975 on bancroftian and malayan filariasis by the Vector Control Research Centre, Pondicherry.

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DIRECTOR

March 30, 1990.

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Contributed by Dr. P.K. Rajagopalan.

FILARIASIS IN INDIA

Over a third of the world's population who are at risk of lymphatic filarial infection live in India[1]. There are 22 million carriers of microfilariae (mF) in India and further 16 million have symptoms and signs of filariasis[2]. Bancroftian filariasis due to *Wuchereria bancrofti* is the predominant type accounting for 98% of cases and is distributed widely in India. Malayan filariasis caused by *Brugia malayi* is limited to a few pockets of Kerala, Assam and Orissa, where more than 90 million people are at risk. Bancroftian filariasis is transmitted by *Culex quinquefasciatus* (an ubiquitous mosquito breeding in polluted water) while Malayan filariasis is transmitted by Monsonioid mosquitoes which breed in acquatic weeds (*Pistia, Eichhornia* and *Salvinia*)[3].

The majority of mF carriers are asymptomatic and most patients suffering from chronic filariasis do not show mF on blood examination[4]. The acute and chronic manifestations of this disease are somewhat different[5]. In the acute stages, Bancroftian filariasis in males presents with acute epididymo-orchitis and funiculitis. These changes do not occur in Malayan filariasis. A common feature of both the acute and chronic stages is filarial fever with lymphandenitis with or without lymphangitis. In chronic Bancroftian filariasis, a hydrocele often occurs in males but is uncommon in the Malayan form. Lymphoedema is the predominant sign of Malayan filariasis in both sexes[5,6]. Bancroftian filariasis occurs more commonly in males[4], but both sexes are equally afflicted with Malayan filariasis[6]. Geographical variations in the clinical presentation of Bancroftian filariasis have been recorded[7]. Recent studies on the natural history of disease by application of clinical grading at lymphoedema indicate that the progression of lymphoedema from early stages to elephantiasis is faster in Bancroftian filariasis - about 9 years in Bancroftian and 14 years in Malayan filariasis[4,6].

Night blood smear examinations still remains the only practicable method for definite diagnosis of mF carriers. The test, though simple, is not sensitive enough to detect low mF count carriers (an estimated 30 % to 35 % are missed[8]). It also does not usually detect patients with chronic filariasis and occult filariasis (see also pp. 7-9)[9]. Membrane filtration, a more sensitive test, is not suitable for mass diagnosis, as it requires venepuncture. To avoid night blood examination, day time (Diethylcarbamazine) DEC provocative test has been used. An adult dose of 150 mg DEC and smear taken after 45 minutes gives the best result. The mF density in peripheral blood is about 30 % lower following day-time DEC compared to night blood examination[10].

Immunodiagnostic tests have been developed for antibody and antigen detection[11]. Several antigens both from homologous and heterologous sources derived from different stages and components of the parasite have been used for antibody detection. The passive haemagglutination test for antibody[12], and the ELISA for antigen in blood and urine[13,14] and antibody detection[15,16] have also been employed. However, immunodiagnostic tests even with the use of monoclonals posed problems of specificity due to cross reactivity with other intestinal nematodes[17]. Species-specific monoclonal antibodies for detection of Malayan filariasis antigen have been produced recently [18]. Immunodiagnostic techniques particularly for detection of antigens in body fluids seems to be promising and need to be tested in the field. Recently developed DNA probes for Bancroftian and Malayan filariasis[19] do not show any advantage over routine morphological diagnosis, since they require presence of intact mF (no circulating parasite DNA has been detected in peripheral blood) and night blood examination. Skin test using *Dirofilaria immitis* adult antigens has not been found suitable for case detection[20] and skin tests using larval and adult *Brugia malayi* antigens showed a high false positivity rate in persons with intestinal nematode worms[21].

Carriers of mF need to be treated with DEC (6 mg/kg/day for 12 days)[22]. Parasite clearance occurs in 80% to 85% of cases with a single course, but two or more courses are necessary for parasite clearance in the rest[8]. Though DEC is primarily microfilaricidal, it is also known to have an action against the adult parasite[23,24]. Both selective treatment of mF carriers and mass therapy of a target population are useful measures to reduce the parasite load in the community; the choice of method would depend on the prevalence of disease and size of the population. Low dose mass therapy by the community members has been found useful in Indonesia[25]. DEC-medicated salt has been used to control this disease[26], but there are certain practical constraints, as alternative sources of salt are preferred by the population. DEC produces side-effects which can affect the earning capacity of people in rural areas[27] and this results in its lower acceptance. Ivermectin, a semi-synthetic macrolide antibiotic found useful in the treatment of Onchocerciasis[28], was recently tried in *W. bancrofti*[29]. A single dose resulted in parasite clearance in 5-12 days. However, in most cases the parasite reappeared within 6 months. Most patients (98%) complained of fever and other side-effects. Clinical trials of this drug on *B. malayi* in South India are now in progress. Testing of several other compounds for their filaricidal activity has met with little success[23].

The exact cause of acute filarial fever episodes is not clear. Acute secondary infections particularly with streptococci have been suggested as a cause but a significant rise in antistreptolysin O titres has not been not been observed[30]. Those harbouring a septic focus such as dental caries, fungal infections etc. suffer from more frequent attacks of fever[31], which makes treatment of primary focus essential. Reinfection[32] and immune reactions[33] may also be the cause of filarial fever. The role of DEC in the management of filarial fever attacks is not clearly understood. Preliminary observations indicate that DEC aggravates acute manifestations and should be given within two weeks of the improvement of symptoms. Antibiotics, anti-inflammatory drugs and antihistamines along with antipyretics are useful in acute stages. Repeat courses of DEC, however, are known to reduce the frequency of filarial fever attacks[32,34]. Conservative management with these repeated courses and other supportive measures such as frusemide, heat therapy, use of crepe bandages and elevation of feet have been found to result in a reduction of lymphoedema in Malayan filariasis. The degree of reduction was 70% in early cases of lymphoedema and 36% in patients with elephantiasis[34]. However, a similar management in patients with Bancroftian filariasis resulted in only a 27% reduction. Some patients (19% in Malayan and 39% Bancroftian filariasis) showed an increase in volume despite treatment[8]. The reasons for the differeing degrees of response are still not understood. Cases which do not respond to conservative management can be treated by one of the several surgical procedures[35] but the recurrence of oedema is a major problem. Lymphovenous anastomosis has been developed for management of chronic lymphoedema and this method is promising as it has shown a 90% success rate[36]. Recent advances in lymphoscintigraphy help locate the site and degree of blockage and may be useful in the management of these patients.

The control of filariasis has received a low priority in our national health policy. Though large populations exposed to the risk of infection live in rural areas, the national programme covers the urban population[37]. It is possible to prevent this disease easily as (i) man is the only definitive host, (ii) DEC is an effective therapeutic agent, and (iii) vectors breed in confined habitats that can be controlled by integrated methods such as environmental management and chemotherapy[38,39].

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ABSTRACTS OF VCRC PUBLICATIONS ON FILARIASIS

A. CONTROL:

1. **Control of Malaria and Filariasis vectors in South India.**

P.K. Rajagopalan, K.N. Panicker AND P.K. Das.

Parasitology Today:3 (1987); 233-241.

Community participation is increasingly seen as a major component of successful control programmes against parasitic diseases. One of the strongest exponents of this has been the Vector Control Research Centre (VCRC) in Pondicherry, South India, who have successfully motivated and involved village communities in vector control activities with considerable success against malaria and filariasis vectors. Their largest single programme, the Filariasis Control Demonstration Project in Pondicherry Town, has now been handed to the Pondicherry State Government, while the VCRC's work on malaria and filariasis control is now expanding throughout other parts of India. As this article shows, much has been learnt from these projects, not just about control techniques but also about education, administration and decision-making.

2. **Effect of controlled release formulation of *Bacillus sphaericus* on Mansonia breeding.**

N. PRADEEPKUMAR, S. SABESAN, M. KUPPUSAMY AND K. BALARAMAN.

Indian J Med Res: 87 (1988); 15-18.

A briquette formulation of *B. sphaericus* was evaluated for its efficacy in controlling the larvae of Mansonia mosquitoes breeding in the ponds of coconut plantations in Shertallai, Kerala State. Three doses of the formulation were tested viz., 7.5 kg active ingredient (ai)/hectare (ha), 15 kg ai/ha and 30 kg ai/ha. The larval population in the treated and untreated ponds was monitored before and after application of the formulation. The Mansonia larval population was reduced considerably in the ponds treated with 15 and 30 kg ai/ha. Reduction in the larval population was first noticed four days after application. The bacterial pesticide was more effective on early instar larvae than on late instars. The formulation exerted residual larvicidal activity for 31 days.

3. **Engineering, mosquitoes and filariasis: a case report.**

S. CAIRNCROSS, A.R. RAJAVEL, P. VANAMAIL, S. SUBRAMANIAM, K.P. PAILY, K.D. RAMAIAH, D. AMALRAJ, T. MARIAPPAN AND R. SRINIVASAN.

Jour. Trop. Med. & Hyg.:91 (1988); 101-106.

The results of larval surveys were used to assess the relative numbers of mosquitoes breeding in different types of habitat and in different parts of the town of Pondicherry, India. The results illustrate an effective method to set priorities for mosquito control by identifying the most significant breeding sites in a town, and show that they are not necessarily the most obvious, the most extensive or those intuitively most likely.

4. **Giant gourami (*Osphronemus goramy:* Anabantoidei) as a potential agent for control of weeds, the breeding source for the vectors of *Brugia malayi*.**

M. JAYASREE, S. SABESAN, K.M. KURIAKOSE AND K.N. PANICKER.

Indian J Med Res:89 (1989); 110-113.

The biocontrol efficacy of giant gourami against various aquatic weeds, which form the breeding source of Mansonioides, the vectors of *B. malayi*, was explored. This fish showed a feeding predilection towards Pistia plant which is the most favoured host of immatures of Mansonioides. A single fish consumed this weed on an average of 206.25 $\pm$ 19.09 g and 316.85 $\pm$ 26.55 g a day under laboratory and field conditions respectively. Techniques developed for the culturing of this fish are also described.

5. **Prevalence of bancroftian filariasis and its control by single course of diethyl carbamazine in a rural area in Tamil Nadu.**

K.D. RAMAIAH, S.P. PANI, N. BALAKRISHNAN, C. SADANANDANE, L.K. DAS, T. MARIAPPAN, A.R. RAJAVEL, P. VANAMAIL AND S. SUBRAMANIAN.

Indian J Med Res:89 (1989); 184-191.

The prevalence of microfilaraemia, clinical spectrum of bancroftian filariasis and vector potential were studied in Vettavalam village in North Arcot District of Tamil Nadu. The effectiveness of selective therapy with diethyl carbamazine (DEC) in controlling filariasis in rural areas was also evaluated. The prevalence of microfilaraemia (mf rate) and disease (disease rate) was found to be 11.7 and 11.09 per cent respectively. Hydrocele was the dominant clinical sign in males and lymphoedema in females. The density of the vector *Culex quinquefasciatus* was 25.44 females/man-hour, and the infection and infectivity rates were 18.16 and 1.09 per cent respectively. All mf carriers detected after the mass blood survey were given a single course of DEC at the dosage of 6 mg/kg of body wt/day for 12 days. Only 61.6 per cent of them took the full course of DEC treatment. DEC therapy brought down the mf rate from 11.7 to 5.84 per cent after one month. In the absence of further treatment, there was no significant change in mf prevalence after one year.

6. **Impact of 50 years of vector control on the prevalence of *Brugia malayi* in Shertallai area of Kerala State.**

P.K.RAJAGOPALAN, K.N.PANICKER AND S.P.PANI.

Indian J Med Res:89 (1989); 418-425.

This article examines the long term effects of vector control on the prevalence of *B. malayi* infection and disease, by comprising the results of 3 earlier studies (1934, 1955, 1976) in one area of south India with a recent (1986) survey. The data indicate that disease and infection prevalence have declined continuously over the last 50 years. Infection has declined (from 21 to 2%) more markedly than disease (from 24 to 10%). Age-specific data indicate that this difference is due to the irreversibility of the clinical signs and the long term survival of diseased cohorts. The results indicate that the prevalence of clinical brugian filariasis can be reduced using vector control and that such control programmes cannot be evaluated in short term or by using crude morbidity statistics.

7. **Bancroftian filariasis in Pondicherry, South India: 2. Epidemiological evaluation of the effect of vector control.**

S. SUBRAMANIAN, S.P. PANI, P.K. DAS, AND P.K. RAJAGOPALAN.

Epidemiology & Infection:103 (1989); 693-702.

This article examines the evaluation of a bancroftian filariasis control programme undertaken in Pondicherry from 1981-5. Integrated vector management was applied in one half of the town, and routine operations under the national programme (larviciding and chemotherapy) continued in the comparison area. The programme was evaluated by monitoring relative change in the epidemiological statistics of both populations. The results indicate that there was significant reduction in prevalence of microfilaraemia in juveniles in the controlled area. An apparent reduction in intensity of microfilaraemia was also observed but this was a consequence of the reduction in prevalence, since the density of microfilariae remained unchanged. The results suggest that primary constraints on the epidemiological evaluation of the vector control of filariasis are the longevity and the population characteristics of the parasite.

8. **Weedivorous fishes for the control of vectors of Malayan filariasis.**

JAYASREE. M, SABESAN. S. AND K.N. PANICKER.

Sent for publication to *Entomon* (1990).

An attempt was made to assess the efficacy of phytophagous fishes viz, *Ctenopharyngodon idella*, the chinese grass carp and *Osphronemus goramy*, the Giant gourami in the control of mansonioides mosquitoes by checking the growth of aquatic weeds which support their breeding. When *Ctenophyngodon idella* and *Osphronemus goramy* were used in monoculture 80.21% and 81.25% of the ponds were kept free from weeds. In polyculture using grass carp in combination with other varieties of carps, only 70.10% of the ponds were prevented from the reinfestation of weeds. Even in the reinfested ponds there was significant reduction (P.05) in vector breeding in all the three types of pisciculture compared to the control ponds. The utility of weedivorous fishes in the elimination of aquatic weeds and thereby breeding of vectors of Malayan filariasis was thus demonstrated.

9. **Control of Brugian filariasis in Shertallai: A strategy developed for vector control through agricultural development programme.**

S. SABESAN, A. KRISHNAKUMARI, AND K.N. PANICKER.

Paper presented in *2nd Kerala Science Congress*, Trivandrum, 1990.

Shertallai, in Alleppey District, Kerala, is highly endemic for filariasis due to *Brugia malayi* for several decades. Disease vector mosquitoes breed in association with aquatic weeds (Pistia, Eichhornia and Salvinia). The growing of such weeds in domestic ponds as a manure source for agricultural purposes is greatly linked with the socio-economic life of the people. In the place of weeds, an alternative better suitable green manure source through the propagation of leguminous plants (Sunnhemp: *Crotolaria juncia*) was advocated. The programme was successfully demonstrated in a village, Ponnittussery under "Sunnhemp village Project" in a collaborative venture towards "complete coconut care programme" undertaken by agricultural development agencies. Vector Control achieved through this strategy as a by-product, is discussed.

10. Comparison of annual and biannual mass DEC administration for the control of malayan filariasis in Shertallai, Kerala.

K. KRISHNAMOORTHY, ABIDHA, J. PRATHIBA, S. SABESAN,P. VANAMAIL AND K.N. PANICKER.

In preparation (1990).

Two rounds of mass Diethylcarbamazine (DEC) therapy at annual single dose of 6mg/kg body wt. and four rounds of DEC therapy at biannual single dose of 6mg/kg were administered in a population of 24,690 and 8,230 respectively in Shertallai which is endemic for malayan filariasis. Population coverage in all the age classes in every round was above 55%. The impact of these two regimens were assessed through the change in the age specific prevalence of infection and its intensity from pre and post control periods. A significance reduction in mF prevalence was achieved and no case of new infection was recorded in 0-9 years age group indicating that mass therapy prevented new infections in children. The reduction was significantly higher in biannual area when compared to annual area. The usefulness of clinical parameters such as recruitment of recent oedema cases and acute cases in the assessment of mass therapy is discussed.

11. Impact of single dose diethyl carbamazine(DEC) on microfilaria carriers of Malayan filariasis.

K. KRISHNAMOORTHY, S. SABESAN, S.P. PANI AND K.N. PANICKER.

6th Annual Conference of National Symposium on Environment and its conservation, Melvisharam, Dec.(1989).

Mass drug therapy with single dose DEC (6 mg/kg body wt.) has been evaluated on microfilaria carriers in Shertallai which is endemic for malayan filariasis. The cure rate and success rate have been analysed and compared with conventional full course of selective therapy. Though complete disappearance of microfilaria was not noticed in all the cases, over 94% reduction in microfilaria density was recorded on the first day following treatment. Lump formation, an indicator of macrocidal effect was also observed in 66% of the cases treated. Fever, the major side reaction following DEC therapy was observed in 70% of the cases. The value of mass therapy in community oriented programmes has been outlined.

12. Utility of food fishes for the control of vectors of *Brugia malayi*.

M. JAYASREE, K. KRISHNAMOORTHY, S. SABESAN AND K.N. PANICKER.

6th Annual Conference of National Symposium on Environment and its conservation, Melvisharam, Dec.(1989).

Composite fish culture involving fast growing edible varieties of major carps such as *Catla catla, Cyprinus carpio, Labeo rohita, Labeo fimbriatus* and *Cirrhina mrigala* has been carried out in the domestic ponds of Shertallai as an incentive to remove aquatic weeds like Pistia, Eichornia and Salvinia which foster the immatures of Mansonioides mosquitoes, the vector of *B. malayi*. Highest survival rate was recorded for *L. rohita* (36.87%) followed by *L. fimbriatus* (26.38%), *C. mrigala* (16.56), *C. catla* (15.59) and *C. carpio* (13.04). Maximum growth rate was observed for *C. catla* (937.5 $\pm$ 460.3 gm/year). Vector breeding was brought down from 80.59% to 28.21% in ponds under fish culture. Besides their utility in vector control the monetary gains accrued to the society through this programme is also discussed.

13. Impact of biannual single dose mass DEC therapy on the transmission dynamics of bancroftian filariasis.

N. BALAKRISHNAN, K.D. RAMAIAH AND S.P. PANI.

International Conference on Biology and control of pests of Medical and Agricultural importance, Madurai, April(1989).

Biannual single dose mass drug administration of diethyl carbamazine (DEC) at the dosage of 6 mg per kg of body weight was carried out in Kottakuppam area in the outskirts of Pondicherry town, known to be endemic for bancroftian filariasis. The impact of the chemotherapy programme was monitored by studying the infection pattern in human and vector (*C. quinquefasciatus*) populations. At the end of one year period, while a decline of infection prevalence and intensity in human population was observed, the impact on mosquito population was not distinct, compared to base line data. The results of the study are presented and discussed.

14. Vectors of filariasis and their control.

P.K. DAS AND P.K. RAJAGOPALAN.

Symposium on filariasis at Annamalai University, Annamalai Nagar, July 1988.

In India filariasis is caused by two parasites namely *Wuchereria bancrofti* and *Brugia malayi* are commonly termed as bancroftian and malayan filariasis respectively. While bancroftian filariasis is widely distributed in urban areas, malayan filariasis is restricted only to few rural pockets in Kerala. Even though experimentally both the parasites can be transmitted by many mosquito species, the major vector species responsible for bancroftian and malayan filariasis are *Culex quinquefasciatus* and *Mansonia* species respectively. While the former breeds in polluted waters the latter breeds in association with aquatic weeds. Both these vectors can be controlled by simple environmental methods provided there is a political will and managerial skill.

15. Integrated vector management for urban filariasis control in Pondicherry.

P.K. RAJAGOPALAN AND P.K. DAS.

ICMR Bulletin:15 (1985); 133-140.

The IVM programme for filariasis control, launched in 1981 for a period of five years, was of a demonstrative nature. Its special features were flexibility in both decision making and operational plans depending on changing needs of the situation. Since the programme was time bound, it was intended to make the programme a success at all costs so that the IVM strategy could be made popular in India. Elaborate planning and preparation preceded implementation of the project. Competent staff, adequate facilities, delegation of responsibilities at all levels, concurrent evaluation and feedback of results into the operational programme and encouragement and support from top administrators were the salient features of this project. There is now a growing realization that urban mosquito control is a community problem and can be solved only through a multi-departmental approach with active community involvement. The role of health department is only to take the lead and initiate action along the lines outlined.

The IVM strategy that had worked well in Pondicherry cannot be transferred to other areas in its entirety since urban mosquito problems vary from place to place depending on many factors. The Pondicherry experiment should at best be followed as a guideline, with suitable modifications, for undertaking similar programmes.

16. Pondicherry's integrated approach scores in Filariasis vector control.

The PEEM Newsletter:12 (1985); 2-3.

The Vector Control Research Centre (VCRC), under the directorship of Dr. P.K.Rajagopalan, has been testing various innovative vector control methods in and around Pondicherry. Five year Filariasis Control Demonstration Project (FCDP) was initiated in Pondicherry in 1981 to control the filariasis vector mosquito, *C.quinquefasciatus*, with integrated vector management(IVM) strategy. Under the IVM strategy environmental management activities, health education of public and intersectoral and institutional linkages were given highest priority. The environmental management activities resulted in the considerable reduction of breeding surface area. The IVM strategy has resulted in drastic reduction of the vector densities. The intersectoral and institutional linkages initiated by VCRC helped in taking some crucial decisions by the concerned departments that help combating the mosquito menace more vigorously. The health education programmes, besides increasing the awareness of the people, changed their attitude, though slowly. Various bodies like Resident's association, citizens' council and an Environmental society were formed which are expected to play constructive role in tackling the mosquito problem.

17. Combating Bancroft's filariasis in Pondicherry, India.

P.K.RAJAGOPALAN.

Public Health (Pub. by: Bayer, Germany,):6; 24-29.

Bancroftian filariasis transmitted by the ubiquitous mosquito *Culex quinquefasciatus* is a major public health problem in India. Nearly 304 million people were exposed to the risk of infection and there are an estimated 20 million people who have microfilaria in their blood. However, decades of the routine control measures of National Filariasis Control Programme (NFCP) failed to tackle the problem effectively. So, a new approach of Integrated Vector Management (IVM) strategy, was implemented over a five year period (1981-85) by the VCRC in Pondicherry to control the filariasis vector. The experience of the scientists at VCRC showed that, the success of IVM strategy depends on the participation of trained personnel, careful assessment of ecological situation, use of right technique and coordination of working teams. The IVM strategy attained its important objective of educating not only the general public but also the public authorities.

The involvement of public and achievement of complete multisector cooperation is a long drawn process. Hence, apart from giving importance to the above, other methods were integrated for rapid vector control. Ecological methods were aimed at elimination of breeding grounds by various measures. The utility of fish, such as Gambusia and Tilapia, as biological control agents, was only of a limited value, since most breeding habitats were polluted in nature. Chemical control methods included the use of insecticides, particularly Baytex, in breeding habitats where either ecological or biological method would not work. Baytex was found to be a better insecticide than the others. No significant resistance in vector could be detected due to Baytex.

The control measures reduced the vector densities appreciably. The incidence of microfilaraemia was reduced by 91% in 0-5 age class in the population.

18. A critical appraisal of filariasis control - A Case Study.

P.K. RAJAGOPALAN AND P.K. DAS.

Paper presented on the occasion of *Diamond Jubilee Celebrations of Haffkine Institute for Training, Research and Testing*, Bombay, Feb 1989.

In India, lymphatic filariasis is a major cause of morbidity if not mortality. In order to develop an appropriate control strategy, a 5 year (1981-1985) demonstration project based on Integrated Vector Management(IVM) was implemented in Pondicherry for the control of Bancroftian filariasis. This article examines the different aspects related to epidemiological evaluation of the control programme, based on pre and post control parasitological data collected from the study population.

Examination of age prevalence profiles showed a significant difference between the pre and post control values in 1-30 years age groups in IVM area. Comparison of relative change of age prevalence between IVM and comparison area, indicated significant difference in juveniles (years) ($p = 0.0009$). Though the pre and post control age intensity profiles showed a clear separation in IVM area, statistical analysis did not reveal any significant difference in change in intensity in both IVM and comparison areas. The decline in intensity in IVM area was a consequence of decline in prevalence. The major difficulties in the evaluation of effects of vector control upon filariasis infection status of a population appear to be the prolonged longevity of the adult parasite and problems related to examination of effect of transmission on a time scale.

19. Environmental control of filariasis in Pondicherry.

P.K. RAJAGOPALAN AND P.K. DAS.

Facets of Environmental problems: (1989); 21-34.

A five year action oriented Filaria Control Demonstration Project(FCDP) was launched by V.C.R.C. with the cooperation of Govt. of Pondicherry, in 1981 to demonstrate drastic reduction in the incidence of filariasis in children by disrupting the transmisson through the control of the vector mosquito, *C. quinquefasciatus*. The starting of the project was preceded by detailed ecological studies on the vector mosquito. The salient features of the project were environmental improvement, flexible control strategy, close interaction of working teams, coordination of various governmental departments and community participation. The adverse effects of mismanaged environments in the proliferation of *C. quinquefasciatus* was enlisted. Various environmental control methods which was accorded top priority, accrued considerable financial benefits and provided permanent solution to some of the perennial breeding problems. The responsibilities of various departments in preventing mosquitogenic conditions are outlined.

20. Efficacy of levamisol at deworming doses in clearance of microfilaria of *Wuchereria bancrofti*.

K.D. RAMAIAH, K. KRISHNAMOORTHY AND S.P. PANI.

In preparation (1990).

Deworming of intestinal nematodes is a regular practice in coastal areas where worm infestation is prevalent. The effect of deworming drugs such as Levamisol on microfilaria carriers of *W. bancrofti* has been assessed in Pondicherry, which is endemic for bancroftian filariasis to understand the im

pact of deworming drugs on parasite population and on transmission. A total of 19 microfilaria carriers of *W. bancrofti* was administered standard deworming dose of 150 mg Levamisole as a single dose and 3 mF carriers were maintained as controls. Complete clearance of mF was observed in 9 cases by 12th day. Though reappearance of mF was noticed in all the cases in any one of the monthly samples taken for a period of 3 months following the drug, there was reduction in microfilaria density in contrast to the controls who showed increase in mF. The impact of this drug on filariasis transmission is discussed.

B. VECTOR BIOLOGY AND ECOLOGY:

21. Biochemical studies of some mosquitoes in relation to development of *Wuchereria bancrofti*.

K. BALARAMAN, P.K. DAS AND P.K. RAJAGOPALAN.

Indian J Med Res:73 (Suppl) (1981); 144-146.

Relative quantity of reducing sugar, amino nitrogen, phenol and protein present in the thoracic muscle of three species of mosquitoes was analysed and their role in the development of microfilaria into infective stage larvae has been examined. It was found that the constitutive proportion of aminonitrogen, sugar and protein does not play any role in development of the parasite and the phenol present was not inhibiting larval development of *Wuchereria bancrofti*.

22. Laboratory studies on the biology of *Mansonia annulifera* Theobald (1901) (Diptera: Culicidae).

R. SRINIVASAN AND K. VISWAM.

Indian J Med Res:83 (1986); 384-386.

M. annulifera, vector of *Brugia malayi* in Kerala, India, has been colonized and a cyclic colony is being maintained at the Vector Control Research Centre, Pondicherry. Studies were carried out on egg hatchability, immature developmental duration, insemination capacity, longevity, gonotrophic cycle and fecundity. Number of eggs per cluster varied from 74 to 146 (average 116.1) and hatchability from 88.03 to 98.32 per cent (mean 94.74 $\pm$ 3.64). The longevity of male and female varied from 2-27 days and 3-32 days respectively.

23. Biting rhythm of the vectors of malayan filariasis, *Mansonia annulifera, M. uniformis & M. indiana* in Shertallai, (Kerala State), India.

N. PRADEEP KUMAR, S. SABESAN AND K.N. PANICKER.

Indian J Med Res:89 (1989); 52-55.

Biting activity of mansonioides mosquitoes through all night collections for a period of two years in Shertallai region, in south India was studied. *M. annulifera* bites uniformly throughout the night, with two peaks of activity, one after midnight (24.00-01.00 h) and another before dawn (04.00-05.00 h).

M. uniformis was found to be predominantly dusk biting, with its peak of activity between 1800 to 1900 h. *M. indiana* showed two peaks of biting activity one after dusk (2000-2100 h) and another before dawn (0300-0400 h). All biting, with its peak of activity between 1800-1900 h. *M. indiana* showed two peaks of biting activity one after dusk (2000-2100 h) and another before dawn (0300-0400 h). All these species following a particular pattern of activity cycles discerned the biting rhythm of Mansonioides mosquitoes to be species-specific.

24. **Laboratory studies on the host plant preference of *Mansonia annulifera*, the vector of brugian filariasis.**

K. VISWAM, R. SRINIVASAN AND K.N. PANICKER.

Entomon:14 (1989); 183-186.

Host plant selection for oviposition and immature survival of the Brugian filariasis vector *Mansonia annulifera* was studied in the laboratory by providing locally available aquatic weeds. Among all the weeds given, *Pistia stratiotes* the water lettuce was preferred for both oviposition and immature survival. The maximum survival rate observed was 85.6 $\pm$ 1.94 (S.E), when reared on *P. stratites*. The developmental duration of immatures varied with different kinds of aquatic weeds.

25. **Seasonal prevalence of *Mansonia annulifera, Ma. uniformis* and *Ma. indiana* and their relative role in the transmission of malayan filariasis in Shertallai, Kerala State.**

S. SABESAN, N. PRADEEP KUMAR, AND K.N. PANICKER.

Sent for publication to Entomon (1990) ?

Three species of Mansonioides mosquitoes, viz, *Mansonia annulifera, Ma. uniformis* and *Ma. indiana* were recorded in the Shertallai region of Kerala State. They were collected resting indoors and biting man throughout the year, except for a few months. Their indoor Per Man hour Resting Density (PMD) and Man Biting rate (MBR) were 3.29, 0.25, 0.10, 24.67, 12.74 and 0.47 respectively. Vector density fluctuated through seasons and reached a peak during the monsoon/post monsoon period when there was an increase in the breeding surface area and a relatively higher survival of the adults. The biting tendency of *Ma. annulifera* and *Ma. indiana* were relatively more indoors (endophagic) while *Ma. uniformis* outdoors (exophagic). All of them showed a predilection towards cattle, with varying degrees of zoophily. The relative abundance, man biting behaviour and a higher transmission potential indicate that *Ma. annulifera* is a more important vector of B. malayi than *Ma. uniformis*.

26. **Spatial and temporal aspects of *W. bancrofti* infection of *C. quinquefasciatus* in Pondicherry.**

K.D.RAMAIAH, P. VANAMAIL AND P.K. RAJAGOPALAN.

In preparation (1990)

The analyses on the variations in entomological parameters like vector density, infection and infectivity rates in different sites of Pondicherry and also during different fortnights was carried out by using analysis of variance and log linear models. The database comprised of the entomological data of two years (1981: pre-control and 1985: concluding year of control operations) for resting

mosquitoes. In the pre-control period, on average, the man-hour density significantly ($F = 16.95$; P.005) varied between the 17 catching sites and between the 24 fortnights ($F = 2.73$; P.05). When the individual factors were considered, there was an overall significant variation in infection rate among the sites ($X^2 = 189.9$; $P = 0.0000$) and fortnights ($X^2 = 64.09$; $P = 0.000$). When the pre-control mF prevalence in humans was introduced as a co-factor for vector infection rate, it was observed that the mf prevalence was significantly associated ($X^2 = 9.26$; P.05) with the infection rate. The variation in infectivity rate was highly significant between sites ($X^2 = 22.32$; P.001) and between the 24 fortnights ($X^2 = 40.37$; P.001). The mF prevalence did not show any significant ($X^2 = 0.49$; P0.05) association with infectivity rate. In the concluding year of control period (1985) the variation in man-hour density between the sites ($F = 21.24$; P.005) and fortnights ($F = 3.216$; P.001) showed that the distribution of vectors are more hetrogeneous compared to pre-control period (1981). The variation in infection rate among the sites was found to be higher ($X^2 = 206$; $P = 0.000$) than that during pre-control year, indicating that the degree of transmission potential varied not only between areas but also at different times, as consequence of different control measures undertaken. The analysis of post control relationship between mF prevalence in humans on infection rate in vector, showed that a close association ($X^2 = 6.744$; P.05) between the parameters compared to pre-control year. The variation in infectivity rates between sites ($X^2 = 26.96$; P.005) and fortnights ($X^2 = 6.28$; P.05) became wider compared to pre-control year. The mF prevalence was not significantly associated with infectivity rate in the post-control period.

C. PARASITE EPIDEMIOLOGY:

27. Some aspects of transmission of *Wuchereria bancrofti* and ecology of the vector Culex pipiens fatigans in Pondicherry.

P.K. RAJAGOPALAN, S.J. KAZMI AND T.R. MANI.

Indian J Med Res:66 (1977); 200-215.

Studies on microfilaraemia, seasonal fluctuations in the density of *Culex pipiens fatigans* and on the infection of the vector by *Wuchereria bancrofti* was carried out in Pondicherry. The microfilaria rate was found to be 17.8 per cent. The disease rate was 1.9 per cent. The indoor resting density ranged between 12.2 and 45.4 (number per man hour) in different months. The biting density also fluctuated between 92 and 387 (number biting per man per night). The infection rates ranged between 6.8 and 12.2 per cent and the infectivity rates between 0.6 and 2.0 per cent. An attempt has been made to quantify the different parameters in the transmission of filariasis in this town.

28. A filariasis survey in Pondicherry villages.

P.K. RAJAGOPALAN, P.S. SHETTY AND N. ARUNACHALAM.

Indian J Med Res:73 (Suppl) (1981); 73-77.

A filariasis survey was carried out in 101 villages in Pondicherry region and microfilaria rates ranging from 0.5 to 15.1 % were found in 76 villages. Both sexes and all age groups had microfilariae in varying degrees. A total of 22,626 mosquitoes belonging to 15 species were collected. Natural infection was found only in four species, namely, *Culex pipiens fatigans, C. vishnui gr. Anopheles subpictus* and *A. vagus*. The possible role of *A. subpictus* in the transmission of filariasis has also been studied.

29. Evaluation of integrated vector control measures on filariasis transmission in Pondicherry.

P.K. RAJAGOPALAN, P.K. DAS, S.P. PANI, T. MARIAPPAN, A.R. RAJAVEL, K.D. RAMAIAH, D. AMALRAJ, K.P. PAILY, N. BALAKRISHNAN, C. SADANANDANE, P. VANAMAIL, S. SUBRAMANIAN, R. SRINIVASAN, N. ARUNACHALAM, C.M.R. REDDY, C.B.S. REDDY AND N. SOMACHARY.

Indian J Med Res:87 (1988);434-439.

A five year integrated vector control (IVC) programme, of a demonstrative nature, for the control of bancroftian filariasis was implemented in Pondicherry from 1981 to 1985. The impact of vector control was assessed by the change in microfilaraemia in the population after five years and the results are presented in this communication. A drastic reduction in transmission was achieved by the IVC programme. There was a general fall in microfilaria (mf) prevalence and mean mf counts in most groups. The other parameters assessed were the annual incidence (per 1000 population) and the infectivity potential of the human population, both of which showed a drastic reduction.

30. A simple deterministic model for host-parasite relationship in *Wuchereria bancrofti* infection and its relevance to parasite regulation in human host.

S. SUBRAMANIAN, P. VANAMAIL, K.D. RAMAIAH, S.P. PANI, P.K. DAS AND P.K. RAJAGOPALAN.

Indian J Med Res: 89 (1989); 411-417.

A deterministic immigration-death model, which reflects the population dynamics of *W. bancrofti* in human host has been applied to study the relationship between vector and human infections. Application of the model showed that the rate of acquisition and loss of human infection were approximately equal ($L = 0.130$ and $M = 0.129$). The relationship of infective resting density (IRD) in vector population with maximum intensity (Imax) of infections and microfilaria prevalence (MFP) in human population were examined by using the least squares polynomial regressions. The fifth order polynomial regressions were found to be adequate to describe the observed pattern (Imax vs IRD: $R^2 = 0.8464$, $P = 0.0015$; MFP vs IRD: $R^2 = 0.7246$, $P = 0.019$). The observed relationships indicated that at an infective resting density of 0.26 per man hour or above, the density-dependent factors start regulating the human infections, which showed a declining trend, following this level.

31. Familial clustering in *Wuchereria bancrofti* infection.

P. VANAMAIL, S. SUBRAMANIAN, P.K. DAS, S.P. PANI AND D.A.P. BUNDY.

Tropical Biomedicine: 6 (1989); 67-71.

The distribution of microfilarial (mF) carriers with *Wuchereria bancrofti* infection was studied in relation to family size. Door to door mF survey data obtained from a rural village, Vettavalam, in south India, were utilized and the analysis was done only for households ($n = 1029$) where all family members were examined. While the distribution of mF carriers in households with less than five individuals was found to be random (Poisson distribution: $P = 0.07$), that for households with more than five individuals was clustered (negative binomial distribution: $P = 0.76$). The analysis of age distribution of mF carriers between the two types of households (i.e. 5 and less and more than 5 individuals) showed

that the proportion of mF carriers below 10 years was significantly higher in households with more than 5 members. Though the distribution of mF carriers differed in the two groups of households, the mF prevalence and it's intensity did not differ significantly between them (P0.05). The probable reasons for clustering of mF carriers are discussed.

32. Bancroftian filariasis in Pondicherry, South India: 1. Pre-control epidemiological observations.

P.K. RAJAGOPALAN, P.K. DAS, S. SUBRAMANIAN, P. VANAMAIL, AND K.D. RAMAIAH.

Epidemiology & Infection: 103 (1989); 685-692.

A 5-year Integrated Vector Management (IVM) project was implemented in Pondicherry, South India. for the control of Bancroftian filariasis. The efficacy of the IVM strategy was compared with routine control strategy under the national programme. The present paper describes the pre-control epidemiological features of filariasis as determined by a mass blood survey in 1981. Of 24,946 persons examined 8.41% were microfilaraemic. Microfilaraemia prevalence was homogenous throughout the study area. The prevalence and intensity of microfilaraemia were age dependent, and increased monotonically until about 20 years, following which there was a decline until about 40 years to become relatively stable in older age classes. The gender profiles of both prevalence and intensity of microfilaraemia showed no difference between the sexes until about 15 years of age, folllowing which both were higher in males compared to females. The distribution of microfilarial counts was overdispersed, indicating aggregation of adult worms.

33. Estimation of fecundic life span of *W. bancrofti* from a longitudinal study of infection in human population in an endemic area of Pondicherry, South India.

P. VANAMAIL, S. SUBRAMANIAN, P.K. DAS, S.P. PANI AND P.K. RAJAGOPALAN.

Indian J Med Res (Accepted for publication; July, 1990 issue).

The fecundic life span of adult female *W. bancrofti* was estimated by longitudinal study of microfilaraemia in a cohort of population (n = 7,525) in Pondicherry. The estimation was based on a deterministic model, using the rate of loss in infection. The life span of the parasite was 10.2 years without chemotherapy, which was reduced to 5.3 years following diethylcarbamazine (DEC) therapy. The analysis of mean microfilarial counts in microfilaraemic persons without chemotherapy indicate that the rate of production of microfilaria by adult female is stable at least for a period of five years.

34. A mathematical analysis of various factors involved in transmission of bancroftian filariasis in Pondicherry.

P. VANAMAIL, S. SUBRAMANIAN AND P.K. RAJAGOPALAN.

Indian J Med Res (Accepted for publication; July, 1990 issue).

The variation of clumping factor in microfilaraemia among different age groups was observed in Pondicherry for 1981 and 1986. It was observed that the clumping factor was minimum in the age group 0-5 years and it was maximum in 16-20 years in 1981 and 21-25 years in 1986. The variation in clumping factor resembled the changes in microfilaria (mF) rate. Multiple linear regression analysis showed

that the multiple correlation between mF rate and the other parameters i.e. median microfilarial density (MFD_{50}), clumping factor in human population, and, infection rate and infectivity rate in vector population was highly significant (R^2 = 0.8624; P,.001). The relationship between filariometric indices in human host and vector population may provide the basis on which a mathematical model on transmission of filariasis could be developed.

35. **Choice and integration of different approaches to case detection with special reference to brugian filariasis in South India.**

K.N. PANICKER, S.P. PANI, S. SABESAN, AND K. KRISHNAMOORTHY.

Indian J Med Res (Accepted for Publication; July, 1990 issue).

Treatment following rapid case detection in population, particularly the target age classes, which record high prevalence, is necessary for effective control of lymphatic filariasis. Conventional door to door surveys result in delay in detection of parasite carriers and clinical cases, particularly in rural areas. An integration with other approaches such as, school surveys, health camps, filariasis clinics and microfilaria detection camps (MDC) was found effective in covering a much larger population in Brugian filariasis case detection in an endemic area, in South India. The MDCs organized through Integrated Child Development Scheme (ICDS MDC) yielded a good coverage of pre-school children. School surveys were ideal in covering children en masse. Community MDCs and health camps arranged with active community participation were useful in covering adolescents and young adults in large numbers. The filariasis clinic was effective in screening older adults above 30 years. The relative efficiency of these approaches in terms of time and man power utilization has been discussed.

36. **Frequency distribution of lymphatic filariasis microfilariae in human populations: Population processes and statistical estimation.**

B.T. GRENFELL, P.K. DAS, P.K. RAJAGOPALAN AND D.A.P. BUNDY.

Parasitology (Accepted for publication).

This paper uses simple mathematical models and statistical estimation techniques to analyze the frequency distribution of microfilariae (mf) in blood samples from human populations which are endemic for lymphatic filariasis. The theoretical analysis examines the relationship between microfilarial burdens and the prevalence of adult (macrofilarial) worms in the human host population. The main finding is that a large proportion of observed mf-negatives may be "true" zeros, arising from the absence of macrofilarial infections or unmated adult worms, rather than being attributable to the blood sampling process. The corresponding mf distribution should then follow a Poisson mixture, arising from the sampling of mf positives, with an additional proportion of "true" mf-zeros. This hypothesis is supported by analysis of observed Wuchereria bancrofti mf distributions from Southern India, Japan and Fiji, in which zero-truncated Poisson mixtures fit mf-positive counts more effectively than distributions including the observed zeros. The fits of two Poisson mixtures, the negative binomial and the Sichel distribution, are compared. The Sichel provides a slightly better empirical description of the mf density distribution; reasons for this improvement, and a discussion of the relative merits of the two distributions, are presented. The impact on observed mf distributions of increasing blood sampling volume and extraction efficiency are illustrated via a simple model, and directions for future work are identified.

37. Frequency distribution of *Wuchereria bancrofti* microfilariae in human populations and its relationships with age and sex.

P.K. DAS, A. MANOHARAN, A. SRIVIDYA, B.T. GRENFELL, D.A.P. BUNDY AND P. VANAMAIL.

Parasitology (Accepted for publication) 1990.

This paper examines the effects of host age and sex on the frequency distribution of *Wuchereria bancrofti* infections in the human host. Microfilarial counts from a large data base on the epidemiology of bancroftian filariasis in Pondicherry, South India, are analysed. Frequency distributions of microfilarial counts divided by age are successfully described by zero-truncated negative binomial distributions, fitted by maximum likelihood. Parameter estimates from the fits indicate a significant trend of decreasing overdispersion with age in the distributions above age 10; this pattern provides indirect evidence for the operation of density dependent constraints on microfilarial intensity. The analysis also provides estimates of the proportion of mf positive individuals who are identified as negative due to sampling errors (around 5% of the total negatives). This allows the construction of corrected mf age-prevalence curves, which indicate that the observed prevalence may underestimate the true figures by between 25% and 100%. The age distribution of mf-negative individuals in the population is discussed in terms of current hypotheses about the interaction between disease and infection.

38. Distribution of microfilaria carriers and clinical cases of bancroftian filariasis in relation to family size, in an urban situation.

P. VANAMAIL, K.D. RAMAIAH, K. KRISHNAMOORTHY, S.P. PANI AND P.K. DAS.

Sent for publication *Indian J Med Res* (1990).

A total of 6,493 persons were examined for clinical manifestations of bancroftian filariasis in 2.1% of the total households in Pondicherry urban area. Of these persons 2339 were also examined for microfilaraemia. The results were used to study the distribution of filariasis cases among the households in relation to family size. Randomness and aggregation of filariasis cases were studied by testing the goodness of fit of the data to Poisson and negative binomial probability statistics respectively. While the distribution of clinical cases was found to be random, the microfilaria carriers were clustered. When filarial cases were considered either to be microfilaraemic or with clinical manifestations, they were found to be aggregated in the households with family size of above 5. The distribution of hydrocele and elephantiasis cases was also found to be random. The epidemiological significance and the probable reasons for the difference in the distribution pattern of microfilaria carriers and clinical cases are discussed.

39. Frequency distribution of *Wuchereria bancrofti* infection in the vector host.

P.K. DAS, S. SUBRAMANIAN, A. MANOHARAN, K.D. RAMAIAH, P. VANAMAIL, B.T. GRENFELL AND D.A.P. BUNDY.

In preparation (1990).

This paper examines the frequency distribution of infection with larvae of *Wuchereria bancrofti* in the vector mosquitoes *Culex quinquefasciatus*. The analysis is based on a large entomological data base collected in 1981 before an integrated vector control programme carried out in Pondicherry, Southern

India. The distribution of microfilariae in nulliparous mosquitoes (reflecting recent infection) is compared with the equivalent distribution of mf from a blood survey of the human population. Overall, the distribution are very similar and therefore reflect equivalent blood sampling processes (modelled by Truncated Mixed Poisson distribution). This is much less than in blood samples. An analysis of the pattern of overdispersion by parasite and vector stage indicates that the distribution of later stages of parasite is less overdispersed than earlier stages, although mosquito stage also has an impact on the results. The implications of this work for the infection process in vectors and the operation of density dependent processes in the vector parasite interaction are discussed.

40. The frequency distribution of *Brugia malayi* infections in human population.

A. SRIVIDYA, K. KRISHNAMOORTHY, B.T. GRENFELL AND D.A.P. BUNDY.

In preparation (1990).

The frequency distribution of microfilaria carriers in relation to mF count was analysed using the data set on parasitological survey results of 22,579 individuals and clinical examination results of 7,766 persons in *Brugia malayi* endemic area, Shertallai. When all mF carriers (532) irrespective of their age and sex were considered, the data were not described by Poisson probability indicating the non-randomness in their distribution. When all amicrofilaraemics were excluded (zero truncated) Negative binomial and Sichel distributions described the pattern of clustering. Age and sexwise analysis were also done and it was estimated that about 1 % of the observed negatives (amicrofilaraemics) were missed positives by the conventional finger prick method. The true prevalence of infection has been calculated after correcting both by sampling error as well as by diseased individuals and its epidemiological significance is discussed.

41. Control of Brugian filariasis in Shertallai, South India: Pre-control epidemiological observations.

P.K. RAJAGOPALAN, K.N. PANICKER, S. SABESAN, K. KRISHNAMOORTHY AND A.S. RAO.

Misc. Pub. VCRC: 7 (1988).

The Vector Control Research Centre (VCRC) has undertaken a project for control of Brugian filariasis in Shertallai, Kerala, South India. The pre-control epidemiological features of endemic Brugian filariasis in the Shertallai were studied by conducting filariometric surveys in 1986. Of the 22,369 persons examined for night blood microfilaria, 517(2.31%) were found positive. In the clinical survey, 7,197 persons were examined and 716 were found to have filarial manifestations, accounting for a disease prevalence rate of 9.9%. The infection and disease prevalence was not homogenous in different parts of Shertallai. The prevalence recorded in western areas was higher compared to others. Age infection and age intensity profiles showed a monotonic rise until about 20 years, following which there was a decline, to become relatively stable in older age groups. Disease prevalence was lower than infection prevalence in early childhood and showed a monotonic rise throughout all age classes. The frequency distribution of microfilaria counts was overdispersed, but was not adequately described by negative binomial probability distribution. Comparison of results of present study with earlier studies showed that the prevalence of filariasis is on the decline.

42. The epidemiological relationship between microfilaraemia dynamics and the development of chronic lymphatic disease in bancroftian filariasis.

A. SRIVIDYA, S.P. PANI, P.K. RAJAGOPALAN,. D.A.P. BUNDY, B.T. GRENFELL.

In preparation (1990).

At the Vector Control Research Centre, databases on microfilaraemia (1981 and 1986) and clinical manifestations (1986) for the population of Pondicherry are available. The age specific rates of loss and acquisition of infection over a period of 5 years for Pondicherry using the reversible catalytic model have been estimated (Vanamail et al., 1989). Present analyses were an attempt to understand the relationship between the prevalence of filarial clinical manifestations and microfilaraemia dynamics. Using the reversible catalytic model and proportion of people who have recovered from infection (who were once microfilaraemic but have lost infection now) was estimated. It was interesting to see that the prevalence of chronic manifestations in males (particularly hydrocele) resembled the proportion who appeared to have recovered from infection in Pondicherry. Thus the epidemiological and statistical analyses provided the first independent confirmation of the immunological theory in Lymphatic filariasis that chronic manifestations are associated with hyper-immune status, which results in elimination of microfilaria in these persons.

43. Mathematical approaches for estimation of true infection prevalence in bancroftian filariasis.

A. SRIVIDYA, P. VANAMAIL, K.D. RAMAIAH, S.P. PANI AND P.K. RAJAGOPALAN.

Sent for publication *Indian J Med Res* (1990).

The conventional method of blood smear examination does not detect all microfilaria carriers. The present article describes two mathematical approaches for estimating the correct prevalence depending whether cross sectional or longitudinal data are available. For cross-sectional database, fitting of suitable statistical distributions to the observed frequency distribution of various microfilaria counts enabled the estimation of proportion of parasite carriers missed by the conventional technique. In Pondicherry, from the 1981 parasitological survey data, it was estimated that between 2-7% of the negatives were false negatives and this resulted in underestimation of the actual prevalence between 25-50% in different age classes. In the other method, using the longitudinal data of a cohort of population (1981 and 1986), the rates of loss and gain of infection over a period of five years were calculated and the prevalence was estimated for the male population of Pondicherry initially. This crude estimate deviated from the observed prevalence of 1986. Since the chronic diseased individuals remain amicrofilaraemic, they were excluded for calculation of corrected gain of infection. Using this corrected rate of gain, a second estimate of prevalence for males was calculated. The results showed that the estimated prevalence using corrected rate of gain resembled the observed prevalence unlike the estimate using crude gain rate. The importance of these approaches is discussed.

44. Relationship of intensity of infection between human and vector population in the transmission of bancroftian filariasis in Pondicherry.

K. KRISHNAMOORTHY, K.D. RAMAIAH, S.P. PANI, P.K. RAJAGOPALAN.

In preparation

Infectivity potential of the human host as well as the vector is the most important factor that deter

mines the force of transmission. The rate of microfilaria intake and its intensity in *Culex quinquefasciatus*, the vector of bancroftian filariasis in relation to the intensity of microfilaria of *Wuchereria bancrofti* in human host were studied in Pondicherry by using 12 microfilaria carriers as bait under field conditions. The mean number of microfilaria, the proportion of vector mosquitoes infected, the proportion of mosquitoes infective and the mean number of L3 larvae per mosquito showed significant (P.05) positive correlation with the intensity of infection in the human host. Concentration of microfilaria, estimated from the observed and expected number of microfilaria intake by the vector mosquito was found to be at statistical limits when negative mosquitoes for mF were also included. However, the regression analysis of concentration factor by considering only positive mosquitoes against human infection shows that there is a significant negative correlation (P.05). The influence of microfilaria periodicity in the human host and the vector biting activity periodicity on intensity of infection in vectors is discussed.

D. CLINICAL EPIDEMIOLOGY:

45. A study on the clinical manifestations of bancroftian filariasis in Pondicherry, South India.

S.P. PANI, L.K. DAS, N. BALAKRISHNAN, C. SADANANDANE, A.R. RAJAVEL, S. SUBRAMANIAN AND P. VANAMAIL.

Indian Medical Gazette: CXXIII (1989); 111-115.

In a door to door survey conducted in Pondicherry, 6493 persons were examined for filarial manifestation. Clinical manifestations of microfilaraemic and amicrofilaraemic persons were also compared by examining 4568 persons who attended the filariasis clinic at Vector Control Research Centre (VCRC). Prevalence of the disease in the locality was estimated to be 6.59%. The disease rate was significantly higher in males (13.67%) compared to females (2.26%). Study of the clinical spectrum showed that hydrocele among males and elephantiasis among females was predominant. Prevalence of lymphangitis was found to be significantly higher in microfilaraemic individuals while prevalence of elephantiasis was significantly higher in amicrofilaraemic persons.

46. Impact of diethylcarbamazine (DEC) with other supportive measures on lymphoedema and related manifestations in Brugian filariasis.

S.P. PANI, K. KRISHNAMOORTHY, J. PRATHIBHA AND A.S. RAO.

The National Medical Journal of India:2 (1989); 260-263.

Diethylcarbamazine (DEC) with other supportive therapy was imparted to 103 recent (RO) and 132 persistent oedema (PO) cases in a *Brugia malayi* endemic area in south India. Response to therapy (reduction/no progression) was noticed in 88 (85.4%) recent and 102(77.3%) persistent cases. Regression in oedema was maximum (70.4%) in RO cases, moderate (52.4%) in PO cases without skin change and minimal (36.2%) in PO cases with elephantiasis. A significant correlation was observed between the degree of reduction and number of DEC courses (upto 5) in RO cases. In PO cases, though number of DEC courses, duration and initial volume of oedema appeared to influence the regression, the data were at limits of significance by statistical test. The possible mechanisms of action of DEC in oedema reduction is discussed.

47. Clinical manifestations in malayan filariasis infection with special reference to lymphoedema grading.

S.P. PANI, K. KRISHNAMOORTHY, A.S. RAO AND J. PRATHIBA.

Indian J Med Res (Accepted for publication; May, 1990 issue).

In a door to door survey in Shertallai area of Kerala State in Southern India, 7,766 persons were examined for clinical manifestations of filariasis. The prevalence of disease was 9.85% and chronic persistent oedema (Grade II) was the predominant clinical presentation in both sexes. There was no significant difference in the age prevalence of disease between the sexes. Incidence of episodic filarial fever was higher (4.73/1000) compared to other manifestations (2.49/1000) in children aged 5-15 years and hence this may be an useful indicator of the degree of occurrence of fresh cases of clinical filariasis. Classification of lymphoedema cases into 3 different grades showed that 1.65% of those examined had developed lymphoedema within 6 months duration. Persistence of oedema (grade II) for prolonged period (13.64 $\pm$ 1.17 years)without skin changes indicated that the development of elephantiasis is a slow process. The clinical picture of malayan filariasis is similar to that reported elsewhere in the world. However, abscess formation in inguinal area was rare unlike that reported in other parts of the world.

48. Clinical epidemiology of bancroftian filariasis: Effect of age and gender.

S.P. PANI, N. BALAKRISHNAN, A. SRIVIDYA AND D.A.P. BUNDY.

In preparation

Results of door to door filariasis clinical survey carried out in Pondicherry during 1986 (Pani et al., 1989) and the microfilaria survey carried out in the same period (Subramanian et al, 1989) were analyzed further to study the age and gender relationship with clinical manifestations. The prevalence of filarial manifestations particularly the chronic ones like hydrocele in males and lymphoedema in females were clearly age dependent. Prevalence of acute manifestations like lymphangitis was independent of age both in females and males. Lymphoedema in females and hydrocele in males were the commonest clinical presentations. Hydrocele in males was responsible for the observed age specific difference in prevalence of disease between the sexes. Quantitative analyses of the data available from 17 different localities in India showed that there was no significant difference in the relationship between gender and clinical manifestations in north and south India, as propounded earlier.

49. Management of side reactions among microfilaria carriers of *Wuchereria bancrofti* following DEC therapy.

S.P. PANI AND K. KRISHNAMOORTHY.

In preparation

Fever and headache are the predominant (90%) side reactions and their severity depends on microfilaria density. Studies were carried out to evolve an appropriate DEC therapy in combination with other drugs which could prevent or reduce the side reactions. Out of 19 mF carriers given only DEC, 16 (78.95%) developed fever. Fever was recorded in four out of seven cases administered with DEC and paracetamol. Only one case (5.56%) out of 18 who received DEC along with paracetamol

and dexopropoxyphene developed fever. Antihistamine combination with DEC could prevent fever only in 7 out of 12 cases. The utility of these drug combinations is discussed from the severity of side reactions.

E. SOCIO-ECONOMIC RESEARCH:

50. Creation of an awareness among the school children on Brugian filariasis in order to involve them in its control.

B. NANDA, S. SABESAN AND K.N. PANICKER.

6th Annual Conference of National Symposium on Environment and its Conservation, Melvisharam, Dec.(1989).

Brugian filariasis caused by *B. malayi* is endemic in central coastal part of Kerala since many decades. Despite being a highly literate state many misconceptions still prevail among the people regarding the causation of this disease. Hence removal of these misconceptions and creation of an awareness among the community was a prerequisite for undertaking any control operations. Since the maximum potential for physical and mental development vests in children it was appropriate to incorporate an intensive health education campaign in the schools of this area, ultimately to involve them in the disease control programme. The methodology employed is discussed here.

51. Some socio-economic aspects of bancroftian filariasis in Pondicherry.

N. BALAKRISHNAN AND S.P. PANI.

International Conference on Biology and control of pests of Medical and Agricultural importance, Madurai, April(1989).

Transmission dynamics of bancroftian filariasis are complex. The role of human socio-economic factors was studied with reference to infection and disease status in Pondicherry, which is known to be endemic for this disease. Microfilaria carriers and persons with definite clinical manifestations of filariasis were enquired about housing pattern, sleeping habit, literacy level, occupation and income status. The awareness of mosquitogenic conditions, personal protetion measures taken if any, were also assessed. For comparison, data available for general population from census records or collected from healthy individuals was utilized. The role of these factors in the distribution of filariasis is discussed.

52. A "People's movement" for the control of filariasis in Shertallai, Kerala State.

AMBILI KUMAR, K. KRISHNAMOORTHY. S. SABESAN AND K.N. PANICKER.

Presented in the *Kerala Science Congress*, Cochin, Feb.(1989).

It is well known that filariasis is basically a man made problem and its control is possible only through

active participation of the community concerned. The largest endemic tract of this disease exists only in Kerala with its concentration in Shertallai taluk, Alleppey District, due to multifarious factors such as ecological, topographical and above all sociological characteristics of this region. An integrated disease control programme has been launched under the Technology Mission Project through the Vector Control Research Centre of the Indian Council of Medical Research. The activities of the project are being designed to make it a truely community oriented programme. In order to achieve this goal, the role of voluntary agencies have been identified and their activities are coordinated and directed towards filariasis control. The strategies employed and the methods adopted in ensuring community participation in the programme discussed here.

F. MISCELLANEOUS:

53. Attempts to establish *Wuchereria bancrofti* in slender loris, *Loris tardigradus*.

P.K. RAJAGOPALAN, A. GAJANANA, P.S. SHETTY AND N. ARUNACHALAM.

Indian J Med Res:72 (1980); 203-205.

Attempts were made to adapt *W. bancrofti* to slender loris (*L.tardigradus*) by infective mosquito bites or by syringe inoculation of infective stage larvae preceded and followed by immunosuppression. The strain failed to develop in the animals.

54. Assay of E and EAC rosette forming peripheral lymphocytes in human bancroftian filariasis.

A. GAJANANA, U.S. BHEEMA RAO, M. NASEEMA, V. SAMBASIVAM, ANDREE KARUNAKARAN AND Z. BASHEER AHMED.

Indian J Med Res:73 (suppl) (1981); 97-106.

Blood samples of 127 adults of Pondicherry a hyperendemic area for filariasis due to *Wuchereria bancrofti* infection (including cases of elephantiasis, hydrocele, lymphangitis, lymphadenitis and microfilariae carriers) were examined for total and differential WBC counts and lymphocyte sub-population by E and EAC rosette tests. The results were compared with 33 non-infected individuals, matched for age, living under similar environmental conditions. Lymphocytes were separated from the blood on a gelatin gradient. Sub population of E_{10} i.e. "functional T cells" was also enumerated. In the infected group, neutropenia, eosinophilia and unaltered lymphocyte counts were observed. EAC rosette forming cells remained unchanged. Total T cells (E_{24}) were less in the group with clinical manifestations. Loss of E_{10} cells was seen in the group showing clinical manifestations, but treated with diethyl-carbamazine (DEC) and other supportive drugs. The group consisting of microfilariae carriers did not show any alteration either in E_{10} or E_{24}. Non-T, non-B ("Null") cells showed an increase in untreated clinical cases and microfilariae carriers. While sera of patients were not lymphocytoxic, about 50% of them showed two times or more inhibition of E rosettes than the mean value for normal controls.

55. Evaluation of Diethyl carbamazine (DEC) Provocative Test for the diagnosis of bancroftian filariasis.

N. BALAKRISHNAN, S.P. PANI, L.K. DAS AND P. VANAMAIL.

Proceedings of the Second Symposium on vectors and vector-borne diseases, Trivandrum:(1988).

A total of 132 microfilaria carriers detected by the conventional night blood examination (NBE) technique were subjected to Diethyl carbamazine (DEC) provocative test (DPT) with four different dosages of DEC. Blood smears were collected at 30, 60 and 120 minutes following the ingestion of DEC. The highest correlation with conventional NBE and DPT was obtained with a DEC dosage of 150 mg and smear taken 30 minutes after ingestion of the drug. The study revealed that DPT is useful in individual case diagnosis in day time, however it may not be suitable for large scale community diagnosis of filariasis.

56. Blood groups and bancroftian filariasis.

S.P. PANI, L.K. DAS, C. SADANANDAME, N. BALAKRISHNAN AND S. SUBRAMANIAM.

Proceedings of the Second Symposium on vectors and vector-borne diseases, Trivandrum:(1988).

A total of 772 persons including microfilaria carriers, diseased and healthy persons were subjected to ABO blood grouping. The study showed that microfilaria carriers with blood group "B" had a significantly higher and group "AB" had a significantly lower probability of developing clinical manifestations of filariasis.

57. Diagnosis of lymphatic filariasis in India.

S.P.PANI.

Presented in *"Workshop on DNA diagnostics in filariasis"*. Dec.18-20:(1989) Jakarta, Indonesia.

Of the world populations at risk of lymphatic filariasis, over 30% live in India. A total of 300 million are exposed to risk of infection, there are 22 million mf carriers. *W. bancrofti* is the predominant parasite species (over 98%), while *B. malayi* is restricted to few pockets particularly in South India.

Currently detection and identification is done based on morphological features either in human blood or in the mosquito vector. Application of immunodiagnosis is limited to research studies. Diagnosis based on morphological techniques is simple and suitable for mass diagnosis, but lacks sensitivity, and more importantly specificity particularly in larval stages in mosquito. Our present interests are to study the transmission dynamics of lymphatic filariasis for developing a mathematical model. The fecundic life span of W.bancrofti has been estimated as 5.4 years. The rates of loss and gain in microfilaraemia under pressure of vector control have been worked out.

Application of a simple deterministic model showed that human infection can occur even when the infective vector density is as low 0.2/man hour. Statistical analysis of distribution of mf carriers show that observed prevalence is much lower than actual prevalence. Microfilaria carriers are found to be clustered in families with 5 members or more. Simulation techniques show that it will take a very long period, to control filariasis, if only vector control is done,hence the need for chemotherapy. All this information has been obtained by using peripheral blood smear examination. Though the impact of control measure has been reasonably measured by data based on morphological detection of parasite

in humans & vectors, there are certain difficulties particularly in recording changes over extended periods of time. More sensitive techniques are expected to provide information valuable for understanding transmission dynamics. For epidemiological uses DNA techniques should attempt not only to differentiate the species but also the stages of the parasite. Detection of single sex infection, will be useful in estimating total worm burden in the population.